Regional Simulation Model (RSM) Peer Review

Interactive Planning Session
Agenda and Meeting Notes

June 22-23, 2005

Meeting Location:

Community Foundation
700 Dixie Highway
West Palm Beach, Florida

RSM PEER REVIEW PART I WORKSHOP AGENDA
Wednesday-Thursday, 22-23 June 2005

Community Foundation
700 South Dixie Highway
West Palm Beach, Florida 33401

Note That Blue Text Items are Hyperlinked to the Presentations

Wednesday	Topic & Presenter
0800 - 0830	**Conference Room Set Up & Socializing as Group Assembles**
0830 - 0845	**Welcome and Role of RSM in SFWMD –** *Dr. Jayantha Obeysekera*
0845 - 0900	**Meeting Logistics –** *Rich Sands*
0900 - 0915	**Goals of the Workshop –** *Dr. Zaki Moustafa*
0915 - 1045	**RSM Theory** *– Randy VanZee and Dr. Wasantha Lal* • Goal 1: Determining if proper and sound scientific approaches were used in the development of RSM, making sure that a self-correcting open process is in place • Goal 2: Evaluating if the conceptual framework of the model contains all of the important hydrological processes necessary to do regional scale modeling in South Florida
1045 - 1100	**Break**
1100 - 1200	**HPM Theory** *– Dr. Eric Flaig* • Goal 2: Evaluating if the conceptual framework of the model contains all of the important hydrological processes necessary to do regional scale modeling in South Florida • Goal 7: Suggesting tests for the HPM approach to simulating local hydrology and making recommendations for improvement or expansion of the approach
1200 - 1315	**Lunch**
1315 - 1345	**RSM Documentation** *– Pattie Fulton* • Goal 5: Making suggestions on the usefulness of the model documentation, including whether the level of detail is sufficient or more is needed, whether the conceptual framework is clear, etc.

1345 - 1415	**RSM Analytical Tests and Validation** – *Dr. Wasantha Lal* • Goal 6: Suggesting any additional tests that may be desired to further validate RSM
1415 – 1430	**Break**
1430 – 1600	**Further Questions and Open Discussion** – *Rich Sands, Facilitator* *Further questions, comments, responses* *Wrap up, review of agenda* *Public comment period*
1600 – 1830	**Peer Review Panel Meeting** – *Ken Black, Facilitator and Dr. Chin, Chair* *Panel organization issues* *Work assignments* *Format for Panel Report* *Scheduling*

Thursday	**Topic & Presenter**
0800 - 0820	**Conference Room Set Up & Socializing As Team Assembles**
0820 – 0900	**Meeting Logistics and Agenda Amendments –** *Rich Sands, Facilitator*
0830 – 0900	**Panel Report on Wednesday Panel Meeting –** *Dr. Chin, Panel Chair*
0900 - 1000	**Water District Overview –** *Dr. Jayantha Obeysekera*
0900 - 1000	**RSM Enhancements and Improvements** – *Dr. Joseph Park* • Goal 4: Making suggestions on modifications and future improvements to the model, including any suggestions for improved computational methods, and future model expansion ideas
1000 – 1015	**Break**
1015 - 1200	**SFRSM Implementation and Application** – *Dr. Ken Tarboton* • Goal 3: Determining the appropriate use of the model in South Florida conditions • Goal 8: Evaluating whether the model is suitable for meeting client goals
1200 – 1315	**Lunch**
1315 – 1600	**Open Discussion** – *Rich Sands, Facilitator* *Further questions, comments, responses*

	Wrap up, review of agenda for Friday tour *Public comment period*
1600 – 1830	**Peer Review Panel Meeting (optional)** – *Ken Black, Facilitator and Dr. Chin, Chair* *Panel organization issues* *Work assignments* *Format for Panel Report* *Scheduling*

Friday	**Schedule**
	A detailed agenda will be provided separately for the panelists participating in the helicopter/airboat tours.

Handouts/Posters

- Acronyms
- Government in the Sunshine
- Speaker Cards
- SFWMD Response to Panel's Advance Questions and Comments
- Presentation Slides
- Miscellaneous Working Maps
- Posters:
  - SEM, ENP – Sharika Senarath
  - MSE – Joseph Park
  - GUI – Rick Miessau
  - CMM – Steve Traver
  - Resources/RSM 2005 components
  - RSM 2005 Gantt Chart

DIRECTIONS TO THE COMMUNITY FOUNDATION BUILDING

Community Foundation
700 South Dixie Highway
West Palm Beach, Florida 33401
(561) 659-6800

FROM I-95 SOUTHBOUND: Take the Okeechobee Boulevard exit, turn left (east) on Okeechobee Boulevard. Pass the Kravis Center and CityPlace. Turn left (north) on South Olive Avenue. Cross over Lakeview Ave (traffic light) and take immediate left (west) onto Trinity Place. Go approximately 100 feet and The Community Foundation building and parking lots will be on your right. The building entrance is on the east side of the building.

FROM I-95 NORTHBOUND: Take the Okeechobee Boulevard exit, turn right (east) on Okeechobee Boulevard. Pass the Kravis Center and CityPlace. Turn left (north) on South Olive Avenue. Cross over Lakeview Ave (traffic light) and take immediate left (west) onto Trinity Place. Go approximately 100 feet and The Community Foundation building and parking lots will be on your right. The building entrance is on the east side of the building.

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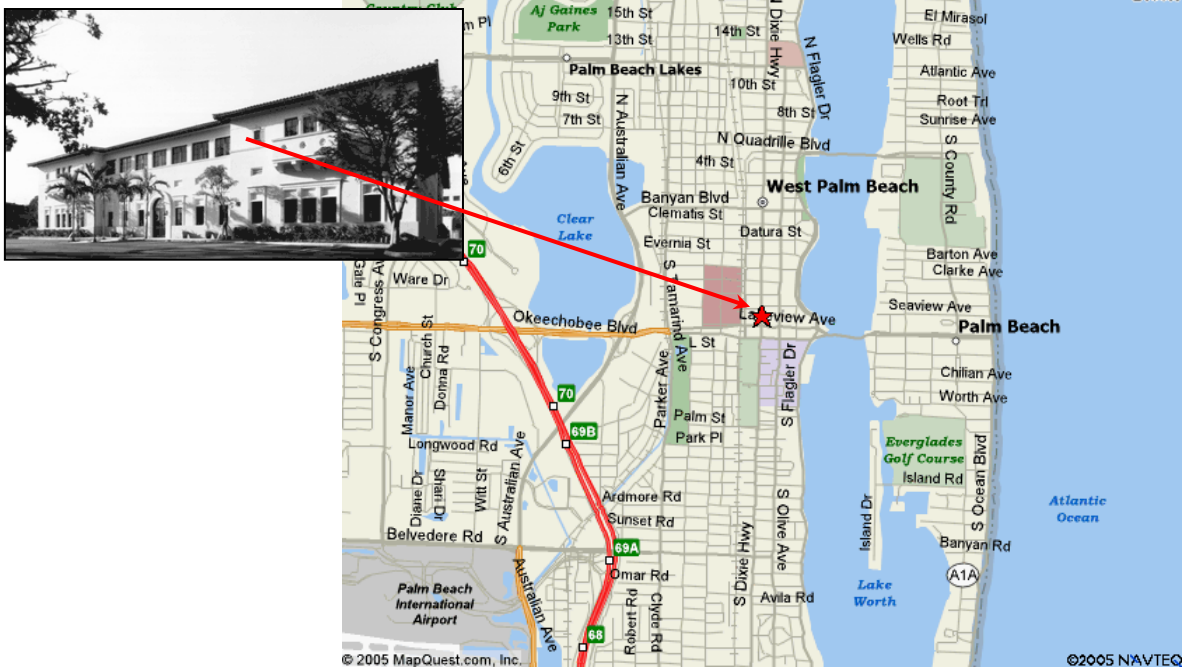

Meeting Notes Recorded by Ken Black of Jacobs

Agenda Item 1: Conference Room Set Up and Socializing as the Group Assembles

Wednesday 6/22/2005 8:37 AM

Day 1 of Regional Simulation Model (RSM) Peer Review

Attendees:

RSM Peer Review Panel

Dr. David Chin, PE, Professor at University of Miami
Phone: (305) 284-3391; e-mail: dchin@miami.edu

Dr. John Dracup, PE, Professor at University of California Berkeley
Phone: (510) 643-4306; e-mail: dracup@ce.berkeley.edu

Dr. Norman L. Jones, PE, Professor at Brigham Young University and Director of the Environmental Modeling Research Laboratory
Phone: (801) 422-7569; e-mail: njones@et.byu.edu

Dr. Victor Miguel Ponce, Professor at San Diego State University
Phone:(619) 594-6070; e-mail: ponce@ponce.sdsu.edu

Dr. René Therrien, PE, Professor, Université Laval, Québec, Canada
Phone:(418) 656-5400; e-mail: rene.therrien@ggl.ulaval.ca

Raymond W. Schaffranek, U.S. Geological Survey Reston, VA
Phone: (703) 648-5891 rws@usgs.gov

Others attendees (click here to retrieve sign in sheets):
Rich Sands
Ken Black
Pattie Fulton
Ken Tarboton
Wasantha Lal
Randy VanZee
Chuck Downer
Trevor Campbell
Eric Flaig
Lucia Perez
Dave Welter
Zaki Moustafa
Angie White
Jayantha Obeysekera

Agenda Item 2: Welcome and Role of RSM in SFWMD – *Dr. Jayantha Obeysekera* (Obey)

8:52 AM - Obey begins opening comments, introduces attendees and begins comments on RSM

- 1993 original scope of work written by Obey
- About 45 modelers in OOM, all advanced degrees, 16 Ph. D.'s
- 3 divisions including Interagency Modeling Center (Akin Owosina), Model Development and Implementation Division (Ken Tarboton) and Model Application Support (Luis Cadavid)

9:00 AM – Obey begins modeling historical perspective (1970's to now) documented in the handout

9:07 AM – Discussing CMM including how this is being used for RSM.

9:09 AM – Discussing RSM design considerations documented in the handout

9:13 AM – Discussing RSM components, emphasizing HSE in this meeting, but he discusses the regional water supply coordination needed and how MSE helps achieve this.

9:17 AM – Discussing new technologies, OO design, computational methods, etc

9:18 AM – Four RSM goals for December 2005 (GIPC):

- Capability Maturity Model (CMM) principles being applied
- GUI development
- Series of Peer Reviews
- Two Implementations SFRSM (future alternatives) and NSRSM (pre-drainage conditions for Everglades)

9:21 AM – Obey notes that posters are scattered around the room for peer reviewers to learn about the SFRSM.

Agenda Item 3: **Meeting Logistics –** *Rich Sands*

9:24 AM - Sands covers the plan for the next three days, discusses local restaurants, etc.

9:28 AM – Discussion of the Florida Sunshine Law, Obey is the official for this meeting, the entire Law provided to Dr. Chin in printed form.

9:32 AM – Public is invited, they can ask questions during the open forum of the meeting on 2:30 to 4 pm on 6/22 and 1:15 to 4 pm on 6/23/05.

Agenda Item 4: **Goals of the Workshop –** *Dr. Zaki Moustafa*

9:35 AM – Moustafa mentions the eight goals of the review, outlines the distributions of comments, and discusses how some comments will be covered in the meetings while others will be addressed in the final report.

9:40 AM – Moustafa completes presentation, some discussion of sunshine law applicability, stressing the need to use the web board for communications

9:47 AM – Ken Black should create Draft report forum on the web board

Agenda Item 5: **RSM Theory** – *Randy VanZee and Dr. Wasantha Lal*

Randy VanZee delivers this initial portion of the presentation

9:54 AM – RSM needed for the following reasons:

- to manage the complexity of the South Florida system;
- lower the cost of admission of using the model compared to the 2x2;
- give flexibility to the modelers;
- to utilize and take advantage of advanced software engineering.

9:59 AM – VanZee discusses **key milestones** in RSM development history, including:

- the significance and meaning of the "oflow" model
- the simultaneous solution of surface/ground/canal water flow
- usage of external solvers
- circumcenter method was developed
- watermover and waterbody abstraction
- Hydrologic Process Models (HPM)
- XML used for input
- Controllers /assessors
- Benchmarks – help make backwards compatibility, assures computational consistency

10:07 AM – Discussion of HSE base classes

- Waterbody
- Watermover
- Hydrologic Process Modules

10:11 AM – VanZee completes conceptual overview

10:12 AM ***Dracup asks for a definition of the roles and responsibilities of SFWMD***. VanZee explains the various aspects of how SFWMD manages water supply (flood control, water supply, water quality, and environmental enhancement).

10:15 AM ***Schaffranek inquires about model cell types***. VanZee explains that the HPM's reflect the land use distributions.

10:19 AM ***Therrien inquires about HPM's being one-way – they feed information into the regional simulation but do not receive information back***. VanZee agrees and explains how on the regional scale, feedbacks are not needed for most applications. The MSE can be used to provide a check of the HPM behavior and can be used to tell the HPM to give a cut-back if needed.

10:23 AM –***Dracup inquires on data quality used in the implementation***. VanZee says data quality varies and a decision is made by Moustafa to discuss data quality in the open discussion forum.

10:24 AM – ***Chin inquires on HPM feedback***. VanZee discusses the freedoms given to programming HPM's and feedbacks can be allowed, if needed.

10:26 AM – Five minute break determined.

10:38 AM – Break concludes.

10:38 AM ***Chin inquires about how the comments will be addressed in the manual: will the comments be added to the manual quickly or over time?*** The District comment responses handed out today in printed form are preliminary responses, some of which will be discussed today (in response to Dracup quick comment). The District plans on covering all comments, including editorials, as they lead up to the completion of the final Peer Review report.

Wasantha Lal continues the Model Development Background and Theory Overview

10:43 AM Lal begins theory discussion outlined in the handout.

- Lal starts by stating that the concepts represented in RSM are not all visible, but they represent our ability to represent real-world behavior, much like mesons and gravitons are used to explain certain high-energy physics behaviors.

10:49 AM – Lal discusses how OO, computational methods and sparse solvers allowed the development of RSM.

10:51 AM – Governing equations are written to achieve conservation of mass, momentum, solute, etc.

10:52 AM – OO design concepts include:

- encapsulation (waterbody)
- inheritance (watermover)
- polymorphism (HPMs)

10:54 AM – RSM is based on the Reynold's transport theorem and the code is written for a generic situation.

The theorem describes the time rate of change in volume (waterbody) and the time rate of change due to flux through the control volume (watermover).

10:58 AM – Momentum equation shown and discussed.

- Local accelerations are neglected = 0,
- inertia = 0,
- diffusion flow has f = 0 and one variable (H) is solved instead of three (H,u,v)

11:01 AM – Sparse solvers (PetSc) allow them to solve nearly singular matrices. Prior to 1994, it wouldn't be possible to solve the RSM equations because the solver speed wasn't fast enough to solve the large matrices.

11:05 AM – The PetSc solver from Argonne National Lab was discussed and its advantages listed.

11:06 AM – A discussion of RSM object types was given including waterbodies and watermovers as well as SV and VS converters, conveyance objects and HPM's.

11:12 AM – ***Dracup asks how mass balance is maintained at the overland/gw flow interface.*** Lal explains that while the waterbody/watermover concept maintains the mass balance in the finite volume formulation which is nothing but a system of equations written for mass balance conditions using head as the state variable, the SV conver is used in converting volumes in the waterbodies to heads in the same waterbodies. Even if they are written in terms of the heads, the mass balance equations in the finite volume method are volume equations which give a specific volume for each waterbody at the end of the solution step. SV converter simply converts that volume to a head.

11:14 AM – ***A question from Ponce regarding canals: do they have flat bottoms?*** Lal describes that for most canals the bottoms are fairly flat. ***Second question: can these canals flow in two directions at the same time?*** Obey says that it can happen, but is rare, with only 1% occurrence of this condition.

11:17 AM – RSM uses SV and VS converters to generically explain the system being simulated, rather than solving 1D and 2D equations for flow in a canal, for example.

11:21 AM – ***Question from Therrien: is the upper figure on slide 15 showing 1 or 2 waterbodies?*** Lal answers, 1 waterbody but multiple water movers.

11:24 AM – ***Question from Dracup: does the E term have [L^3/t] dimensions?*** Lal: no, they are velocities [L/t].

11:26 AM – ***Question from Chin regarding SV converters and their behavior when the groundwater gets close to the land surface.*** Lal is going to show an example of an SV converter to help explain their behavior.

11:27 AM - Diffusion flow conditions explained as shown on slide page 17.

11:29 AM - Overland flow conditions explained as shown on slide page 18.

11:34 AM – Lal explains the conditions for overland flow as shown on page 18. ***Dracup and Chin ask minor questions about nomenclature, Ponce asks about dimensional consistency of T equations on slide 18. Ponce asks what are d and l?*** D is distance between circumcenters and l is the length of the wall interface between cells. ***Ponce asks where are u and v?*** Lal gave an explanation stating that u and v are derived from essentially the depth averaged shallow water equations that are left after dropping all the inertia terms. These expressions are explicit.

11:43 AM – Lal continues to explain that in the Everglades situation, the simplifying assumptions used (Raviart and Thomas, 1977) in deriving the equations have been shown to be reasonable.

11:46 AM ***Therrien asks two questions: (1) did you test any other methods of averaging other than arithmetic? (for h and n equations on slide 18). (2) What happens when one cell has overland flow and the neighbor doesn't. How is the transmissivity computed?*** Lal answers (1) by saying that he didn't test other averaging methods. He says it might need to be tested in the future for cases which have inertial effects included. Lal is going very fast during the answer to number (2) and is using example numbers and talking about typical behaviors in the Everglades type simulations and data quality issues such as data precision. I'm not sure what to write about it.

11:50 AM ***Schaffranek asks about testing of grid spacing to investigate the behavior of the equations on page 18.*** Lal says he has completed some testing.

11:51 AM ***Therrien rephrases his question and uses the rooms as water bodies and the door as the water mover. He asked about how the groundwater is computed.*** Lal explains how the equations are solved: two separate watermovers are written – one for gw and one for sw.

11:57 AM ***Black asks Lal for more clarification about the condition previously mentioned of one waterbody with overland flow and an adjacent cell without ol flow.*** Lal goes through an explanation of this condition and how it is solved.

11:57 AM ***Black asks Lal for more clarification about the condition previously mentioned of one waterbody with overland flow and an adjacent cell without ol flow.*** Lal goes through an explanation stating that a number of conditions are conducive to overland flow as described by the description of the overland flow water mover. They include not only conditions under which the upstream cell has water but also that the

upstream head is higher than the downstream head or the ground level of the downstream cell.

11:59 AM Time for a one-hour lunch break. Lal will pick-up his discussion after lunch.

1:06 PM – lunch break ends and Lal begins where he left off in the morning with the overland flow watermover equations on slide 19.

1:13 PM Lal shows the Hirsh textbook examples showing cases of good and bad watermover formulations shown on slides 22 and 23.

1:16 PM Lal discusses canal flow watermovers shown on slide 24 and canal seepage watermover shown on slide 25.

1:19 PM Discussion of stage and volume converters and inverters. Lal shows how this approach follows from the Reynold's transport theorem. ***Schaffranek indicates that this SV approach cannot account for ridge and slough topography cutting through a cell.*** Lal indicates that it cannot represent this type of micro-topography exactly.

1:26 PM - ***Chin asks if RSM will be used for flooding projection or spatially varied flooding areas.*** Lal gives an explanation describing how SV capabilities can be used to have partial flooding, and how the flood level obtained using RSM considers partial flooding. With GIS mapping, this level can be converted to areas. This analysis is of course limited because certain momentum and conveyance terms are not considered in the current formulation. ***Tarboton asks for the reasoning behind the question because it is a goal for RSM to predict flooding.*** Tarboton indicates that the increased resolution provided by the new RSM grid provides better predictive capability of flooding. VanZee adds that in certain applications such as the L-8 example, partial flooding areas can be determined and used as calibration targets.

1:36 PM - ***Chin comments that he would avoid the term "sediment layer conductivity" in slide 25.*** Lal agreed with this statement and indicated he also wasn't comfortable with this term.

1:39 PM - Brief description of the HPM's and discusses slides 30-33. He moves onto the mass balance description and discusses how all the pieces fit together.

1:43 PM – ***Ponce asks if the SV curve is static (i.e., is the curve set independent of the hydrologic conditions used in the model and the curve doesn't change over time).*** Lal indicates that there are SV curves for all areas of the model and these represent the microtopography of those areas.

1:47 PM – Lal indicates that the regional solution is solved implicitly but the HPM's are explicit and assumed to be local in space and time, as defined on slide 36. The solutions are first-order accurate and Regional-HPM is kept simple.

1:50 PM – On slide 37, the term alpha is used as a weighting factor in an attempt to improve the simulation results.

1:54 PM – ***Therrien comments on the use of the alpha weighting factor and the term implicit.*** A truly implicit solution is when alpha =1, Crank-Nicholson when alpha = 0.5, and explicit when alpha = 0. ***He also asks a question about the lowermost equation on slide 37 and whether iteration is used.*** Lal gives a long explanation of how the code used to iterate but now, after many years of trials, iteration is no longer used. It was explained that the iteration with updated matrices was not necessary in RSM unlike in the case of SFWMM because of the use of the SV converter which could transform the volume of the waterbody to a cell head at any stage of the iteration without a mass balance error. Mass balance during the single iteration is not violated as long as the system of linear equations is solved. The price to pay for not iterating more with updated matrices is in the numerical error of the solution. It was found that this error is within the first order error range which is what you get even after iterations. This shows that the need for intensive iterations is less. Some of these ideas should be tested more in the future. ***Ponce also remarked on the term alpha (a different definition of alpha compared to Therrien) and asked for an explanation of the effect of alpha on the solution.*** Lal gave an explanation describing how alpha = 0.5 is ideal if it works as in the case of benchmarks, but is impossible most of the time because of instability. As a result, alpha has to be increased closer to 1. There may be other times in the future where iterations may be needed to solve non-linear problems – ***this was said in response to comments made by Schaffranek regarding iterations.***

2:02 PM – ***Therrien again mentions that MODFLOW uses Picard iteration and this is needed to ensure mass balance.*** Dave Welter mentions that RSM does a head updating based on the SV relationship, and this isn't done in MODFLOW (it is done via iteration). This difference may be why iteration isn't needed in RSM. Lal sums up by saying that iteration may have to be added later.

2:11 PM – ***Chin asks about HPM's and the mass balance equation on slide 34.*** He mentions that consistency is needed in the HPM figures that show the Q from water supply going either one way or both ways. Lal says that they will update the figures and make sure the equations are consistent.

2:16 PM – Lal works through the last three slides. ***Chin asks about why if the matrix equation is solved in terms of head, why are SV converters needed?*** Lal explains that the solution is solved for delta Head, which is really a change in volume, and the new head is calculated from the VS inverter.

2:25 PM – ***Chin recommends changing the term E in the momentum equation to V (slide 9).*** He gave reasons why this change should be made.

2:26 PM – ***Therrien asks what happens in the solution when the water level drops in a canal to below the bottom of the canal.*** He indicates that the solver wouldn't like that

because the transmissivity term drops to 0. Lal describes how water is borrowed from the home cell to refill water to the bottom of the canal. This borrowed water is reported in the mass balance table, and VanZee indicates that the model user will be notified of this difficulty and should strive to minimize this occurrence.

2:31 PM – ***Therrien asks if a heavy storm event could be simulated where a near-surface ponded condition develops above the water table.*** Van Zee indicates that HPM's could be used to simulate this behavior.

2:32 PM – ***Schaffranek asks a question about numerical behavior of RSM.*** Lal gives a detail response to this question but I couldn't keep up with his answer.

2:33 PM – 5 minute break specified

2:50 PM – Break has finished.

Public comment period has just opened and no comments have been received. The period will now be closed.

Agenda Item 6: **HPM Theory** – *Dr. Eric Flaig*

2:51 PM – Review of key HPM Concepts shown on slide 2

2:55 PM – HPM's can incorporate existing code from others; this is already completed for AFSIRS.

2:56 PM – ***Dracup asks about urban consumptive use.*** Flaig responded by saying that HPM's can be written to do anything desired. He gave multiple examples of how water can be complexly distributed for multiple reasons. ***Chin elaborated on the bi-directional arrows previously mentioned for the water supply component of the HPM***. Flaig responded by saying that this item will be checked and other consistency comments will be addressed.

3:06 PM – Flaig discusses HPM types (Natural System, Agricultural, and Urban). He indicated the desire to expand the list of existing HPM's.

3:09 PM – ***Dracup asked about collecting data for all of the triangles in the 6 mile square area depicted in the current slide.*** Data exists for land-use type and data is collected from local water municipalities and county extension. Obey added that GIS land-use coverages exist and physical data can inferred from the land-use distribution. Flaig talked about how complex HPM distributions are set, how they are used, including how the information is processed with mass balance tools.

3:15 PM – ***Schaffranek asks about how precipitation is entered into the model.*** Obey commented that over 500 rain gauges exist and spatial and temporal interpolation is used as a pre-processing step to create the model rainfall input file.

3:17 PM – ***Ponce asked how rainfall is converted to runoff.*** Flaig stated that all HPM's have their own abstraction methods. In a typical daily time step simulation, infiltration-limited runoff is not necessary in the sandy soils because the rainfall reaches the water table within this time frame.

3:20 PM – ***Schaffranek asks about the characterization of paved areas.*** Flaig states that HUB are used for these areas. Flaig shows examples of how an agricultural area (slide 11) and an Urban area (slide 12) are discretized into HUBS. Flaig shows the HPM distributions shown in poster form on the back wall.

3:26 PM – Examples of default, simple and comprehensive HPM's were given.

3:29 PM – Flaig summarizes the review comments into 4 categories as shown in slide 19. He quickly moved onto the HPM implementation slide and discussed how these features are created using the GIS.

3:33 PM – Options for conducting testing and verification examples were outlined.

3:36 PM - ***Therrien asks about runoff options in HPMs vs runoff in HSE.*** Flaig gives an orange grove example where both forms of runoff can exist. Another case he mentioned failed, so in that model, the structural settings of the model need to be modified. ***Therrien mentioned the usage of the HELP model and its potential as a verification test case against RSM.***

3:43 PM – ***Chin comments on the lack of basic governing equations for HPMs.*** He wasn't able to understand the functioning of HPMs without this information. Flaig states that he didn't present the details today because the comments from the panel were mostly related to PRR and Mbrcell. He assumed that the panel didn't have problems with the other HPMs. He also stated that some HPMs are not as accurate as others because they contain less complete descriptions of the local hydrologic processes but that they are included to give users multiple choices. ***Schaffranek recommends checking equations for dimensions and consistency.***

3:54 PM – ***Ponce asks has potential ET is calculated.*** It is computed outside the model using a method described in a paper that Ken Tarboton is going to provide to the panel. ***Ponce suggests adding ET to RSM so that if Temperature is input, ET can be calculated.***

4:00 PM – ***Chin asks whether there are any verification / validation testing that exists for HPM's.*** Flaig responded that verification is difficult because of lack of data but that some field data exists that could be tested for a couple of urban and agricultural areas. ***Chin continues emphasizing the need to validate the HPM's because models can be calibrated with incorrect conceptualization and formulations.***

Agenda Item 7: **RSM Documentation** – *Pattie Fulton*

4:06 PM – Pattie presents information on RSM documentation – the entire suite of documents are listed in slide 7.

4:14 PM - Pattie asks reviewers for input on particular items listed in her slides. There are questions posed to the reviewers that the District wants the reviewers to include in the report.

4:16 PM – ***Ponce recommends some thought be given to the term "theory" versus "reference" for the current "Theory Manual".***

4:18 PM – ***Schaffranek requests terminology list, math symbols, and dimensions be given for all equations in the Theory Manual.*** Black notes that the HSE User's guide contains all dimensions for model input parameters.

Agenda Item 8: RSM Analytical Tests and Validation – *Dr. Wasantha Lal*

4:22 PM Five methods of testing and analysis will be discussed

4:24 PM Lal rapidly moves through slides 1 through 6

4:29 PM Lal discusses model run time and maximum error chart and mentions that not only do the proper spatial and temporal discretizations need to be properly selected, the solution method must be correctly chosen.

4:38 PM – Tidal data needs hourly representation in the time step to achieve 1% error.

4:41 PM – ***A short discussion between Ponce and Lal occurred on the calculated time for simulation estimation equation in slide 10.***

4:49 PM – "Badness Testing" exists and should be used for helping design the model grid.

4:51 PM – ***Ponce asked how model results would be perturbed by changing the 1 day time step choice (and accompanying grid) to 0.5 day.*** Lal said that the error resulting from this change would be on the order of 1 to 1.5%.

4:55 PM – Lal discusses the guiding principals in slide 17.

4:57 PM – Lal begins the discussion of the aquifer/canal study used to estimate aquifer parameters. He moves through the discussion quickly because of a time shortage.

5:05 PM – Lal discusses early test cases and moves through the rest of the presentation quickly due to time constraints.

5:09 PM – ***Chin asks about the typical cell size***. Lal indicates that the cell size will be dependent upon the requirements of the model. Tarboton gives max, min and average cell sizes of the SFRSM.

5:13 PM **– *Schaffranek asks if it is possible to have variable time stepping.*** Lal indicates that they should implement this feature. They had this before PetSc was used, but this feature was removed along the way.

5:18 PM – ***Therrien asks about the publication of the verification tests.*** Fulton responds by indicating that the Benchmark guide exists but will be expanded in the future. Fulton notes that this guide is on the peer-reviewer web site.

Agenda Item 9: Open Discussion – Rich Sands

No public comments were received and the panel was satisfied with the day's progress and the questions that they had have already been asked, so no open discussion ensued.

Agenda Item 10: Peer Review Panel Meeting – Dr. David Chin

The peer review panel met to discuss the events of the day and how to prepare for the peer review status report to be presented tomorrow morning. No notes were taken during this time except by Dr. Chin, and these notes were used to formulate the report to be presented tomorrow.

This completed Day 1 of the RSM Peer Review

Day 2 of RSM Peer Review

Thursday 6/23/2005 8:44 AM

Attendees:

RSM Peer Review Panel

Dr. David Chin
Dr. John Dracup
Dr. Norman L. Jones
Dr. Victor Miguel Ponce
Dr. René Therrien
Raymond W. Schaffranek

Others attendees (click here to retrieve sign in sheets):

Rich Sands
Ken Black
Pattie Fulton
Ken Tarboton
Wasantha Lal
Trevor Campbell
Eric Flaig
Dave Welter
Michelle Irizarry
Jorge Rivera
Raul Novoa
Joseph Park
Rick Miessau
Randy VanZee
Jorge Rivera
Zaki Moustafa
Jayantha Obeysekera
Chuck Downer

Agenda Item 1: Opening Comments – Dr. Jayantha Obeysekera (Obey)

8:45 AM – Obey introduces new attendees, discusses plan for the day, future work plans, etc.

Agenda Item 2: Meeting Logistics – Rich Sands

No comments recorded.

Agenda Item 3: Peer Review Panel Update and Status – Dr. David Chin

8:47 AM – Discussion of the proposed structure of the peer review report
8:48 AM – The structure is:

- Exec Sum
- Intro
- 8 peer review goals listed in individual sections
- Summary and conclusions

Moustafa asks if preliminary comments will be included as an appendix. Chin responds that these comments would provide the content for the client goals and would not be included as an appendix.

8:51 AM ***Obey requests another section be added to the report and placed before the summary and conclusions section.*** The purpose of this new section is to attempt to answer whether the RSM is the best available tool for long term planning and modeling in South Florida.

8:54 AM ***Schaffranek asks if client goals could be given to the panel in written form.*** Obey indicates that the District will discuss these during the meeting today.

8:55 AM Chin continues with the panel plan

- Panel input to chair by July 1
- Six other intermediate target dates listed
- Draft Report by July 15
- District Response to Draft Report by August 19
- Final Report by September 9

8:57 AM Chin continues with the plans for today's panel meeting. The panel will discuss Documentation issues (8 listed items), Technical issues (2 items), Other issues (e.g., client goals)

Additional (New) Agenda Item: Water District Overview – *Dr. Jayantha Obeysekera*

Obey announced that a new topic is being added to today's agenda. This discussion is being added to help the peer reviewers understand the roles and responsibilities of the SFWMD and to gain a better understanding of the water management system.

9:00 AM – ***What is the water management system?*** Obey will discuss this and the role of the SFWMD.

The SFWMD is the regional water management agency. They get involved in regulatory aspects of permitting. The modelers have to have a regional model to help solve client's goals. Ecosystem restoration is a client of the Office of Modeling (OoM). A lot of details were presented on slides, many of which help to quantify the complexity of the water management system. Some facts include:

- EAA is sugarcane area
- 1800 miles of canals and levees
- 160 drainage basins
- 2000 water control structures
- 27 pump stations

9:06 AM The SFWMD will operate the storm water treatment areas which are the largest engineered wetlands in the world (they are nearing completion). New reservoirs are also being built as part of restoration program.

Obey discusses the Central and Southern Florida Project which is intended to provide flood control and other purposes.

- Kissimmee River is being de-channelized.
- Detailed discussion of the flow system in Southern Florida
- Physical system complications are increasing with additional system components and operations are becoming more complicated with new regulatory rules and competing interests.
- A Lake Okeechobee example will be discussed. If large slugs of water are released from Lake Okeechobee during times of excess water, damage can arise in the downstream areas.
- If canals need water to minimize salt water intrusion, the water is delivered from the interior system.
- EAA generates 1,000,000 acre-feet and they need 400,000 acre-feet and they are concerned when operations of Lake O operations are changed. EAA is simulated as a special case since it is the primary ag area and has special features such as 8 feet of subsidence compared to the Natural System.
- ***It is impossible to keep up with Obey during this talk*** … too much information for me to record.
- RSM needs to be able to manage the operations of the water control structures.

- Obey discusses the major objectives of CERP including reservoirs, canal elimination, deep freshwater injection
- The road raising should occur over the next 5 years, total CERP estimated at 50 years.

9:23 AM ***Obey discusses how the various systems are defined – they are shown in map view***

- Large well fields exist in the Biscayne aquifer along the lower east coast (LEC). When canals don't receive enough water and provide recharge to this aquifer, salt water intrusion can occur along the LEC. This is why changes to the regulatory operations of Lake Okeechobee concern planners in the LEC.

- Models are used during drought periods to help decide on water usage rates and to propose restrictions if needed.

- There are numerous performance measures (>900 in the 2x2 model) used to investigate how client needs are being addressed.

- The water control system will be changing and the RSM needs to be able to simulate these changes.

- The model needs to be able to be used in the regulatory planning mode to show that changing operations will not change the water resources that people currently receive.

- It is now mandated that all models and tools used in the future for water supply management must now be peer reviewed.

- The RSM is NOT being advertised as a tool to be used for flood control. More detailed models need to be used for this purpose.

- The operations division uses 36 year simulation results to help in their planning.

9:34 AM ***Lake Okeechobee multi-objective management problem is discussed in some detail***

- Climate forecasts are used to help plan for Lake O management.

- The RSM needs to be able to simulate the WSE Operational Guidelines Decision Tree developed for Lake O.

- Operators use a 15-minute management timeframe while the model contains a 1-day time step.

9:37 AM Obey asks for questions.

- The MSE is an attempt to decouple the management controls from the model code so that arbitrary (user-defined) controls can be entered in the model as needed.

9:38 AM Opinion by Ken Black.

- This is an excellent presentation and Obey delivers it in interesting fashion, with a great depth of knowledge. The District should consider translating this information into a chapter for inclusion in the RSM documentation suite since it helps explain the complexity that is so often the topic of conversation and which in large part is the driving force behind the need for advance modeling tools like RSM.

Agenda Item 4: RSM Enhancements and Improvements – *Dr. Joseph Park*

9:39 AM – Park begins with a discussion of the MSE design goals. These are listed in his first slide, which can be accessed by clicking on the blue hyperlink above.

9:42 AM – Early approach to MSE is detailed in slide 3

9:45 AM – The MSE design was reformulated (slide 4) with assessors introduced to allow the pre-processing of HSE state information.

9:47 AM – Slide 5 continues to show the continue refinement and begins a lengthy (but very interesting!) historical development of neural networks and universal approximators and their relationship to the water management system.

9:54 AM – The MSE controllers and supervisors are listed in slide 6.

9:56 AM – The simple canal segment test model is shown with examples of different types of controllers demonstrated. ***Therrien asks for more information on the charts and then asks a question regarding how the flow is actually modulated.*** Joseph replies that the watermover flow is amplitude modulated by a value between 0 and 1. Lal expounds upon this by explaining that the 0-1 flow amplitude modulation naturally expresses that a gate opening is applied or a pump flow rate is changed. Joe indicates that the sigmoid feedback controller was shown to work better than the PID controller.

10:05 AM – Lal discusses how the MSE controller signals were shown to him to be effective.

10:10 AM – Discussion continues on how MSE relates to the physical system; Joe mentions a time-step disconnect between the model and the real world. The model is 1 day, real-world is minutes. The controllers need minute-level time stepping to be effective and this difference in time-stepping is currently limiting their ability to use MSE for simulating the real system control algorithms.

10:14 AM – ***Dracup asks whether MSE material being presented is included in their SOW.*** The District responses from Rich, Pattie, Obey and Joe all indicate that this presentation is ancillary information and that the Peer Review Panel should comment on the 9 pages in the theory manual. Other comments on the MSE approach presented would be appreciated.

10:17 AM – ***Therrien asks whether the 2x2 has controllers like MSE.*** Park responds that the control information is embedded in the source code and some optimization is conducted during the simulation through iteration.

10:19 AM - Park presents results from the supervisor evaluation conducted using a partial model of the LEC.

10:23 AM – Supervisor evaluations continued with the development of the SFRSM. Subsequently, testing began on more regional-scale models than were tested before.

10:26 AM – Three deficiency in the approach were identified during this larger scale testing. These are detailed on a slide but are summarized here:

1. Controllers and supervisors have no feedback with concurrent HSE state information.
2. With the use of User defined supervisors, the coding was getting complex.
3. Providing a modular, extensible, easily understandable implementation of MSE with User Defined Supervisors and Controllers would be a challenge.

10:30 AM – the MSE network was then abstracted from the HSE network to provide a stream flow and hydraulic structure representation which simplifies the expression of control constraints and provides a unified data store for MSE relevant state information.

Assessors were then added to provide estimates for daily time-step simulations. ***Therrien asked if a look-ahead in HSE is possible to help the assessors estimate upcoming conditions during the next daily time step.*** The District responded that this is not included at this time. However, work is currently underway to incorporate this capability.

10:36 AM – Park continues discussing the role of the assessors.

10:39 AM - Assessors didn't solve all of the problems being experienced with the MSE. There are 4 issues listed on the last slide that provide information on where MSE is headed, including sub time step iterations between HSE and MSE.

10:42 AM – ***Chin asks about the role of the MSE in the RSM. Is it capable of more than just providing planning information to operators, considering limitations in how the system is managed in reality?*** Joe responds that the inherent computational limitation of SFRSM (daily time step) may not be appropriate for operational control decisions which are based on sub-daily time scales. Obey indicates that SFRSM is primarily a planning and operational policy assessment tool, a regional model aimed at addressing large timescale, regional water policy planning issues.

10:51 AM – ***Therrien asks about the run time for RSM.*** Joe responds that 60% of the time is spent in matrix inversion and the majority of the time remaining is spent on IO and a few other tasks take a few percent of the time.

Break and re-adjourn at 11:03.

Agenda Item 5: SFRSM Implementation and Application – *Dr. Ken Tarboton*

11:07 AM – Tarboton begins discussing the conditions for appropriate use of models in slide 5.

11:10 AM – Moving to the model examples that have been used to refine RSM.

11:12 AM - Kissimme Basin simulation is the first example, used for proof of concept and speed of solution (CPU requirements). This example was also simulated by a Berkeley team with 2 second time steps vs 6 hours with RSM.

11:16 AM – ***Ponce asks Lal a question about a diffusion wave speed, or how to find the transition from steady to unsteady flow***. Lal responds with a technical answer that I am unable to reproduce due to the detail included in the response.

11:21 AM – Tarboton briefly covers the Everglades National Park example and moves onto L-8 drainage example followed by Loxahatchee National Wildlife Reserve example.

11:22 AM – The RSM highlights and lessons are shown for each model on slides 7 to 15. *This is good information for documenting the history and capabilities of RSM.*

11:24 AM – Lal explains what it means for proof of concepts. Some detailed discussion occurred regarding the existence of the dynamic wave. The conversation was too detailed to record accurately.

11:30 AM – ***Chin comments on the need to better define the terms verification and validation.*** There are verification examples that exist for RSM but he hasn't seen any validation examples. ***Therrien agrees with this comment.***

11:31 AM – Tarboton continues moving through the existing applications of RSM.

11:38 AM – Moving onto the Mission Statement stated on slide 17. The calibrated and verified model will exist by Dec 2005. The model should include some regional level operations.

11:40 AM – Tarboton shows SFRSM grid and begins discussing assumptions. ***Schaffranek asks about how water is moved from Lake O to the surface water.*** Lal responds with a discussion of watermovers that have been written for this purpose.

11:43 AM - ***Schaffranek asks why the tidal mixing zone was included down on the southerwestern part of the domain.*** Lal responds that by having the mixing zone included allows more accurate boundary conditions to be selected. Tarboton also mentions that the 2x2 model domain did not include this zone and this was a criticism of the 2x2. Moustafa mentions that data along the southwest coast has only been collected

over the past 3 years. Tarboton recommends that the panel give input to the District on these types of issues.

11:51 AM – ***Jones asks about how the remainder of the western boundary was selected***. Tarbonton responds that these are water basin boundaries and these are shown graphically.

11:54 AM – ***Ponce asks about the implicit solution and whether Lal has tested if this method leads to more stable solutions.*** Lal responds with some technical details of his testing history of explicit vs implicit, and the fully implicit schemes have to be used with responsibility. Lal indicates that you cannot "cheat" with explicit schemes but you can with implicit schemes.

11:58 AM – Tarboton continues with slide of peer review comments.

12:00 PM – Details of cell sizes

- 23,896 cells
- Area = 9730 square miles
- Average cell size = 0.4 square miles
- Smallest = 0.2 square miles

12:02 PM – 2x2 model was started in early 80's and became operational in about 1985.

12:03 PM – Tarboton discusses canals and structures shown on slide 24. ***Dracup asks a question about whether the structures are automatically managed***, and Ken responds that some structures have to be manually controlled.

12:09 PM – Tarboton continues showing slides of topography and hydraulic conductivity (K) distribution. ***There were a couple of questions about the K distributions – how were they determined (Black) and how are they perturbed (Jones)?*** Tarboton answered these by saying that the District hydrogeologists have determined the K distributions and Welter briefly metioned how the K's are perturbed during parameter estimation.

12:13 PM - ***Ponce asks if soils maps exist.*** Flaig says they do but they are not being used at this time. Flaig indicates that these maps will be included in future HPM documentation.

12:14 PM Final slide (22) show the land use map and some discussion ensues on starting the model with simple land use coverages followed by adding more complexity as needed, depending upon problems encountered during calibration. Additional discussion occurs on how vegetation type variations within large land-use areas are simulated. Flaig discusses several approaches being used/tested in the NSRSM to handle anisotropy in Mannings, ridge and slough topo, etc. ***Ponce recommends mapping the soils because in the future, people will be asking about it.***

12:26 PM– Break for lunch
1:31 PM – Lunch ends

1:32 PM Tarboton continues the presentation with information on calibration of SFRSM (slide 27).

- Domain split into three basins: LECSA, LOSA, and Glades
- Subteams broken out and 5 phases of calibration defined.
- Subteams are nearly completed with phase 2 and have made progress on stage 3.
- ***Jones asks about parameter estimation methodology*** and Lal responds by stating that the District that SVD was used over the past few weeks. ***Jones suggested looking at PEST and SVD assist because of recent advancements (some papers will be published in WRR) and that thousands of unknowns can be estimated with little computational load.*** Tarboton states that the District is using a subcontractor to assist with auto-calibration.

1:46 PM Glades, Lower East Coast Surface Area (LECSA), and Lake O Surface Area (LOSA) basin approaches (slide 28-30) are discussed.

1:53 PM – Tarboton reviews initial calibration results on slide 31. ***Therrien inquires about R^2 and indicates the possible need of using the correlation coefficient, which is just R.***

2:05 PM – Several questions were asked about the calibration stats. Tarboton answered some of the the questions.

1. ***Ponce talked about using multiple stage calibration data sets.***
2. ***Chin mentioned the use of the Nash performance measures.***
3. ***Jones comments on the bias plots indicating that the symbols should be all circles with multiple colors.*** Tarboton indicates that this is just a display issue because in the printed version, multi-colored circles are used.

Lal talks about data quality over these long records of observation and that "data error" and "data deficiencies" do exist. Moustafa indicates that 10% error can exist in flow measurements.

2:15 PM Tarboton talks about why rain wasn't included over the canals. The canal area is about ½% of the total domain areas, not including the secondary and tertiary canals. He indicated that rain over the canals might be added at a future time. Soft calibration targets are used to compare RSM results to SFWMM results. Some discussions ensued on the differences between the SFWMM simulation results and the RSM simulation results. ***The panelists indicate that the District should be careful comparing soft calibration targets because of differences in plan-view model areas, discretizations, etc.*** Because the RSM has smaller cell sizes, the distributions of ET and rain could be different than the SFWMM if higher-resolution ET and rainfall coverages are interpolated and used to apply these terms to cells in the model. ***A series of short and diverse comments were made about other calibration issues, most of which could not be recorded because of their brevity.***

2:34 PM Tarboton moves onto the NSM pre-drainage application

Ponce asks about the Manning's n distribution, with values of 1 being used (Ponce indicates 0.8 should be about the maximum value used while Schaffranek says a Florida researcher found Manning's ranging from 0.38 to 0.52). Lal says that this term should be used carefully. The Manning's value of 1 has been used in this model and Lal does recognize that it is high. He gives some justification that the natural topographic variation of the system includes areas where sheet-flow is not smooth and water has to move around obstacles. ***Detailed discussions ensue with Ponce, Lal, Obey and Chin discussing the values of Manning's n.*** Lal doesn't want to push the value of n too large because it can create problems in the simulated results. ***Dracup notes that Rouse Hunter wrote a paper (1942 in ASCE transactions…) that could provide some insight into proper parameter selection.***

2:47 PM Back to NSM. Initial simulations being conducted from 1965 to 1995 (slide 36).

2:52 PM Introduction to client goal #8.

Chin asks for a definition of the District's clients. Tarboton indicates internal modelers, internal clients (e.g., water supply division) , and consultants that might use RSM are all considered clients.

Dracup asks for examples of litigation that the District has been involved in. Obey covers a lot of information fast. Obey indicates that lawsuits occasionally occur and modelers get involved because models are usually used in studies related to water (planning, regulatory, etc). A question always asked is "Is the model peer-reviewed?". Typically environmental groups will file the lawsuits.

3:02 PM – Client input on their goals was solicited and the six goals on slide 39 were determined. **All six goals are expanded into more detail on slides 40 to 45.**

3:12 PM – Tarboton moves onto slide 46, which describes initial run time and file size.

3:14 PM ***Chin inquires about client goals: (1) to what extent is RSM better than SFWMM in structured flow calculations?*** Ken says we don't know the answer to this at this time. ***(2) does RSM have improved hydraulic simulation of canals?*** Ken defers to VanZee or Lal. VanZee indicates RSM has a more sophisticated way of handling flow through canals. Ultimately more functionality will be gained, but a number of other issues have occurred which make implementing the MSE more difficult. ***Schaffranek indicates that more rigorous calibration will be needed with the improved canal formulation, including the measurement of flow in the canals.***

3:21 PM ***Additional comments about flow in canals occurs between Lal, Ponce and Schaffranek.*** Discussions wander around, generally most issues related to the difficulties of simulating canals in the real world. Are accelerations terms needed? Will dynamic solutions be needed in the future? Many issues batted around without well-defined conclusions.

3:29 PM ***A Public comment is received on the populating the NSRSM grid versus the SFRSM.*** The commenter noted that there are differences in the meshes which would not allow the physical properties to be transferred from one grid to the other.

3:30 PM Break time.

3:50 PM Break over. RSM GUI tools. Pre-processing uses ESRI GIS and Post-processing uses python.

3:53 PM Python was chosen because it is open source. Tarboton quickly moves through the remaining slides showing examples of the GUI.

Agenda Item 6: Open Discussion

3:56 PM Moving into open discussion. Sands covers tomorrow's itinerary.

4:10 PM The open discussion period ensued with the panel members discussing the report format and the work that is required to finish it.

4:19 PM ***Jones asks why can't the time step be reduced, considering the modest run times?*** Lal responds that smaller time steps could be used if needed, but they are thinking that as long as the model is behaving nicely, there is no reason to go to a smaller time step. Obey says that numerical reasons might trigger a smaller time step (e.g., stability, not matching the physical processes in 1 day time step).

4:21 PM ***Dracup asks how the operators use the water management model.*** Obey responds that the models are used for longer term planning, not for real-time operations decisions.

4:24 PM ***Jones asks if parallel processing has been considered.*** Obey responds that Linux clusters are being used but the code has not been written to take advantage of parallel systems.

4:30 PM ***Jones asks about output file formats.*** Jones recommends to the District that they look into the use of HDF5 format file for RSM. ***Jones will send information to the District on this file format..*** File compression is very good with this format.

4:35 PM ***Jones asks about HPM's and hubs.*** Jones recommends clustering the similar HPM's together in GIS and writing a GIS application to assign these to the mesh cells. VanZee agrees.

4:38 PM ***Jones asks about 3D groundwater flow.*** VanZee indicates that the 3D capabilities are not sufficiently documented to show them to the peer reviewers. This is considered a work in progress.

4:40 PM ***Therrien asks about anisotropy in the 2D groundwater solution. Will anisotropy be installed?*** Lal says it is on the list and they think that they know how they will do it, but they haven't written the code.

4:42 PM ***Jones asks a calibration question.*** He mentions some assumptions in MODFLOW and compares RSM to it. Lal and he talk about a few things in this regard.

4:47 PM Ponce asks about sensitivity to the alpha weighting factor. He recommends doing sensitivity testing of time step and/or the alpha factor. A long discussion ensues about the weighting factor. Lal discusses his testing history about this topic.

4:53 PM. ***Ponce asks if the model goes unstable under any circumstance?*** Lal responds that short, deep canals, can cause this type of problem. ***Ponce asks will this***

model go unstable 2 years from now if he is the new user? What documentation exists to help the user in times of need? Lal responds that error analysis is documented and will be included in one of the manuals. This methodology will allow users to choose time stepping and grid size for given material properties.

5:06 PM ***Therrien explains his concerns regarding the lack of iteration and how he expects emerging problems with this approach, especially when MSE is superimposed.*** He recommends that there are ways to pull out the problem areas and solve them with only 1 matrix inversion. VanZee agrees and suspects that this type of problem is what is causing them grief now and will be the focus of their work over the next 6 months.

5:10 PM ***Jones discusses the Horizons to 3D mesh utility in GMS 6, for creating 3D grids. He also discusses new file formats that should be investigated by the District.***

5:19 PM Time for the panel discussion after a short break.

Agenda Item 7: Peer Review Panel Meeting

No notes taken by Ken Black. The notes were taken by Dr. Chin.

End of Day 2 of RSM Peer Review